DETECTION OF SERPENTINE AT JEZERO CRATER.

E.Z. Noe Dobrea[1] and R. Clark[1], [1]Planetary Science Institute (1700 East Fort Lowell suite 106, Tucson – AZ -85719; eldar@psi.edu).

Introduction: Jezero Crater has been selected as the landing site for the Mars 2020 mission. The crater, which is site of a paleo-lacustrine basin, has been the subject of extensive photogeological and spectroscopic studies. It contains a variety of geological and mineralogical units of astrobiological interest, including two fan deposits, as well as km-scale deposits of carbonates, phyllosilicates, and sulfates. Most of spectral work thus far has focused on constraining spectral signature to one spectrally dominant mineral, and associating geologic units to that one mineral. In reality, minerals usually occur in assemblages, whose composition can provide important information on its genesis. In this work, we used the USGS Tetracorder to constrain the mineralogical assemblages of materials within Jezero Crater.

Background: Jezero crater has been studied in the thermal (TIR ~ 5 – 60 μm) and visible through near infrared (0.35 – 4 μm) using spectral and hyperspectral imaging data, respectively [1 – 4]. Using VNIR (0.34-4 μm) data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) aboard MRO, [2, 3] reported the first identification of phyllosilicates and carbonates within Jezero crater and the associated catchment region. [4] used imaging data from the High Resolution Imaging Science Experiment (HiRISE) and the Context Camera (CTX) as well as CRISM hyperspectral data to identify several geomorphic and spectral units exhibiting signatures consistent with igneous and alteration phases within Jezero and the associated catchment; and placed these units into stratigraphic context. Most recently, [1] derived modal mineralogy of these units using TIR spectra from the Thermal Emission Spectrometer, and showed that they consist of mineralogical assemblages dominated by plagioclase and pyroxenes, with carbonates and smectites present in abundances no greater than 9% and 27%, respectively.

Tetracorder: The USGS Tetracorder is an spectral analysis tool that uses a digital spectral library of known minerals and a modified-least-squares method to test for the presence of mineralogically diagnostic bands in spectral data on the basis of band position, shape, and depth [5]. Tetracorder simultaneously tests different portions of the spectrum to fit multiple spectral features from multiple materials, allowing the identification of mineral assemblages, if present [6]. Since its inception, Tetracorder has been central to dozens of studies on the Earth [7], the Moon [8], and Mars [9], as well as ices on the satellites of Jupiter and Saturn [10]. With 30+ years of development, the robustness of Tetracorder's mineral assignments has been repeatedly demonstrated on the Earth.

Datasets and Methods: We focused our analysis on CRISM Map-Projected Targeted Reduced Data Records (MTRDR), which have been photometrically and atmospherically-corrected map-projected hyperspectral images. These data have also been corrected for spectral smile and geometrically reconciled. The MTRDR data were mosaiqued in ENVI and subsequently analyzed using Tetracorder.

Results: We identified and mapped diversity of minerals that included primary igneous such as olivine, pyroxene, and feldspar as well as aqueous alteration products including serpentines, smectites, and carbonates (Fig. 1). Sulfates were tentatively detect on the basis of a 1.93-1.94 μm absorption, but mapping them using band-fits proved challenging given residual effects from the correction of the 2-μm CO_2 triplet.

Olivine of primarily high Fo number was identified from a broad Fe^{2+} charge transfer feature centered around 1.047 It was found primarily in association with mantling, ripple-bearing units.

Pyroxene: High and low calcium pyroxene were identified on the basis of broad features centered around 2.27 and 2.1 μm. High calcium pyroxene (augite) is more common, occurring in association with olivine-bearing rippled units, as well as Low calcium pyroxene (pigeonite) is identified in small (~1 km), discrete outcrops on the western rim of the crater.

Feldspar (bytownite) was identified by broad Fe^{2+} feature centered around 1.29 μm (Fig. 1). It occurred in association with carbonate-bearing outcrops located the crater's rim, as well as in association with olivine in discreet light-toned outcrops on the crater floor.

Serpentines were detected on the basis of diagnostic absorptions at 2.31-2.32 μm and 2.38-2.39 μm (Fig 3). Based on the position of the 2.31-2.32 μm band, the observed spectra are most consistent with lizardite. They are most dominant spectroscopically in outcrops on the crater rim, but are also observed in association with buttes east of the fan deposit and, to lesser extent, on the fan deposit itself.

Smectites were detected on the basis of their 2.28-2.31 μm combination band. They are broadly distributed throughout the scene, dominantly present on the fan deposit.

Carbonates were detected on the basis of their 2.3

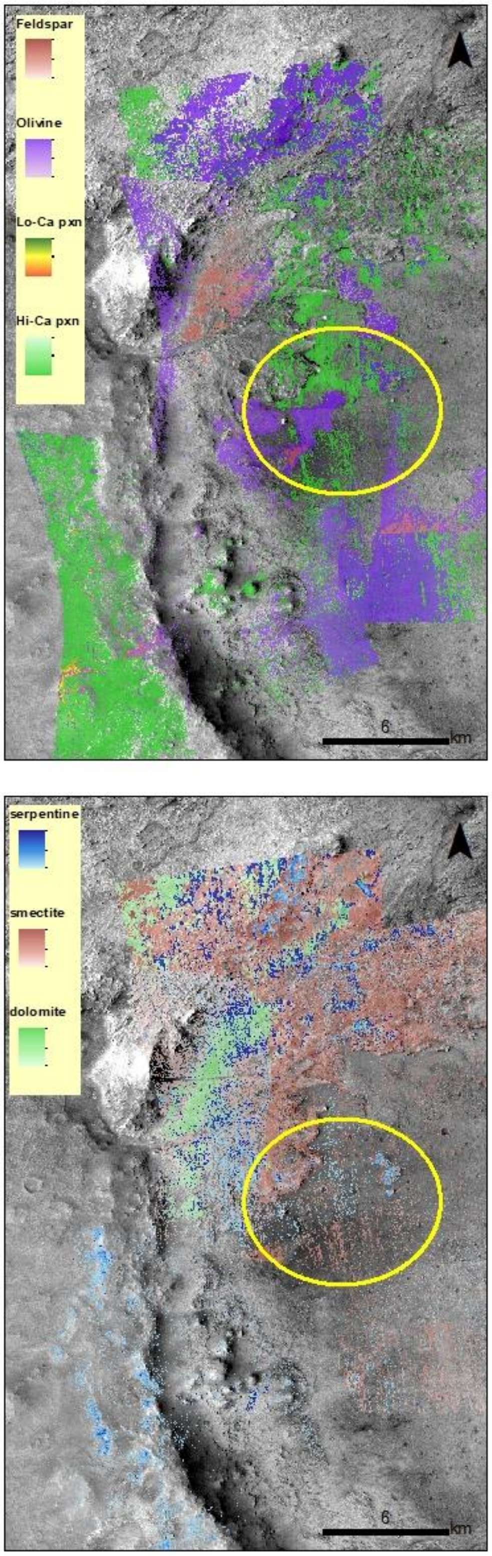

Figure 1. (Top): Distribution of primary mafic minerals. (Bottom): Distribution of aqueous alteration products. The yellow outline is the planned Mars 2020 landing ellipse.

μm band. They are most spectrally dominant in association with light toned outcrops occurring both inside and outside the western rim of the crater.

Discussion: Our results are broadly consistent with those of [1-4]. However, the new identification of serpentine can provide additional insight into the geological history of the crater and inform target selection for the Mars 2020 rover.

References: [1] Salvatore *et al.* (2017), *Icarus*. [2] Ehlman *et al.* (2008) *Nature Geosci*. 1, 355-358. [3] Ehlmann, *et al.* (2008) *Science* 322, 1828-1832. [4] Goudge, *et al.* (2015) *J. Geophys. Res.* 120, 775-808. [5] Clark, R.N. *et al.* (1990) JPL Publication 90-54, p. 176-186. [6] Clark, R.N. *et a.l* (1991) JPL Publication 91-28, 2-3. [7] Swayze *et al.* (2014) *Economic Geology*, 109, 1179-1221, [8] Clark et al. (2009) *Science*, **326**, 562-564. [9] Ehlmann, *et al.* (2016), *Amer. Min.*, 101, pp 1527-1542. [10] Clark, R.N. *et al.* (2012) *Icarus*, 218, 831-860.

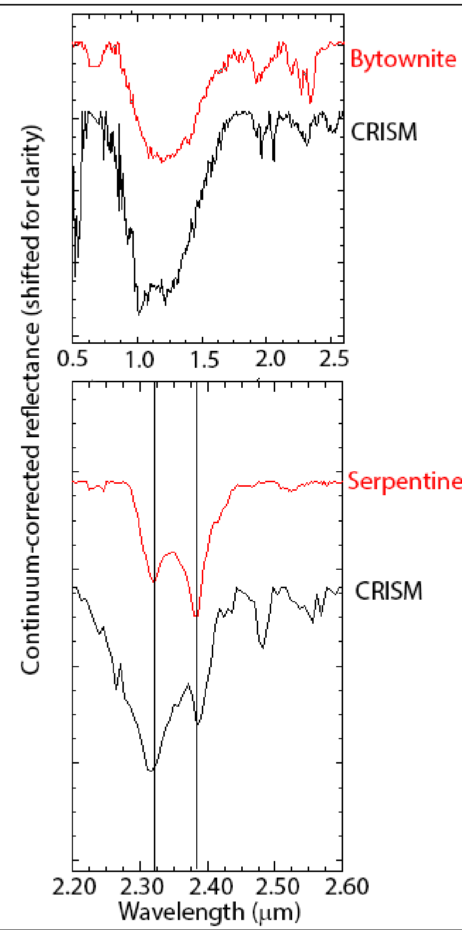

Figure 2. (Top) Continuum corrected spectra of bytownite (USGS HS106.3B - red) and CRISM spectrum on carbonate-bearing unit. (Bottom) Similar comparison between serpentine (CRISM NCCR02 - red) and CRISM average of about 200 pixels on the crater rim (black). Vertical lines are at 2.32 and 2.38 μm.